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STUDY OF GLASS BATCH COMPONENTS SEGREGATION

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The separation of glass batch components during storage and shipment is examined. Segregation in a two-component soda – sand system is studied. It is shown that practically all soda, being the lightest material, moves into the upper layers of the batch. A study of the segregation of different fractions of powdered dolomite showed that mechanical action on powdered dolomite redistributes the fractions: the coarse fraction dislocates into the upper layers while the fine fraction remains at the bottom.

Key words: glass batch, segregation, separation of components, capillary force, capillary strength.

Nonuniformities of glass batch loaded into a furnace seriously disrupt technological processes. The stringent requirements imposed on batch, such as uniformity of the chemical composition, constancy of the particle-size compositions, absence of segregation, dusting, and volatilization of the components, often make the batch preparation process decisive in the manufacture of high-quality glass articles. When powder batch is used workshops become dusty and raw materials consumption increases considerably because of wear. When such batch is loaded into a furnace losses of high-volatility components and their emission into the atmosphere occur and the service life of glassmaking furnaces is shortened. Uniformity of a prepared glass batch is a temporary property. In production a uniform batch separates because of vibrations and mechanical actions. For this reason a thorough analysis of possible separation of the components of batch is urgently needed [1]. The present article discusses the segregation of batch particles in a two-component soda – sand mixture and the separation of dolomite fractions along the vertical direction under mechanical actions.

Experimental Procedure. The experiments were conducted using the special apparatus shown in Fig. 1*a*. The main part of the apparatus is a hollow plastic cylinder *1* (∅35 mm, $l = 185$ mm) with a piston *2*. The rod *3* is used to move the piston. A special cap *5* closes the cylinder at the top.

The free-flowing bulk material used in the present investigations was placed inside the cylinder, filling it approximately half-way. Next, with piston lowered to the base the

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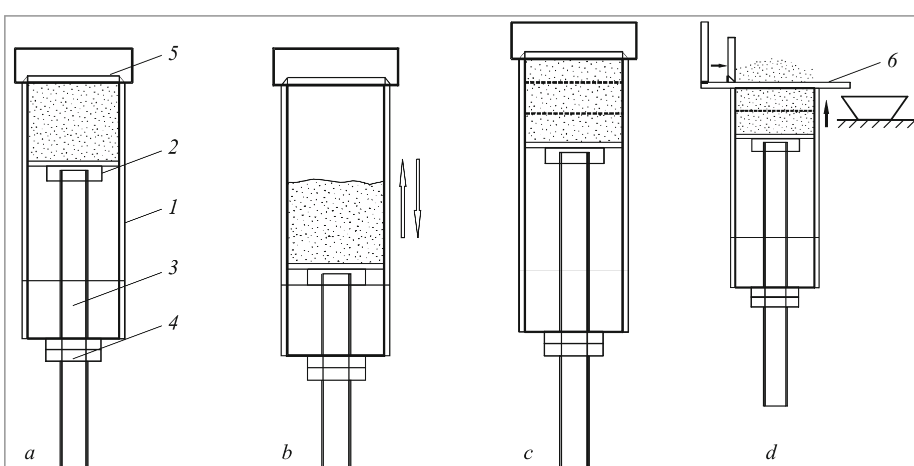

Fig. 1. Diagram of the apparatus.

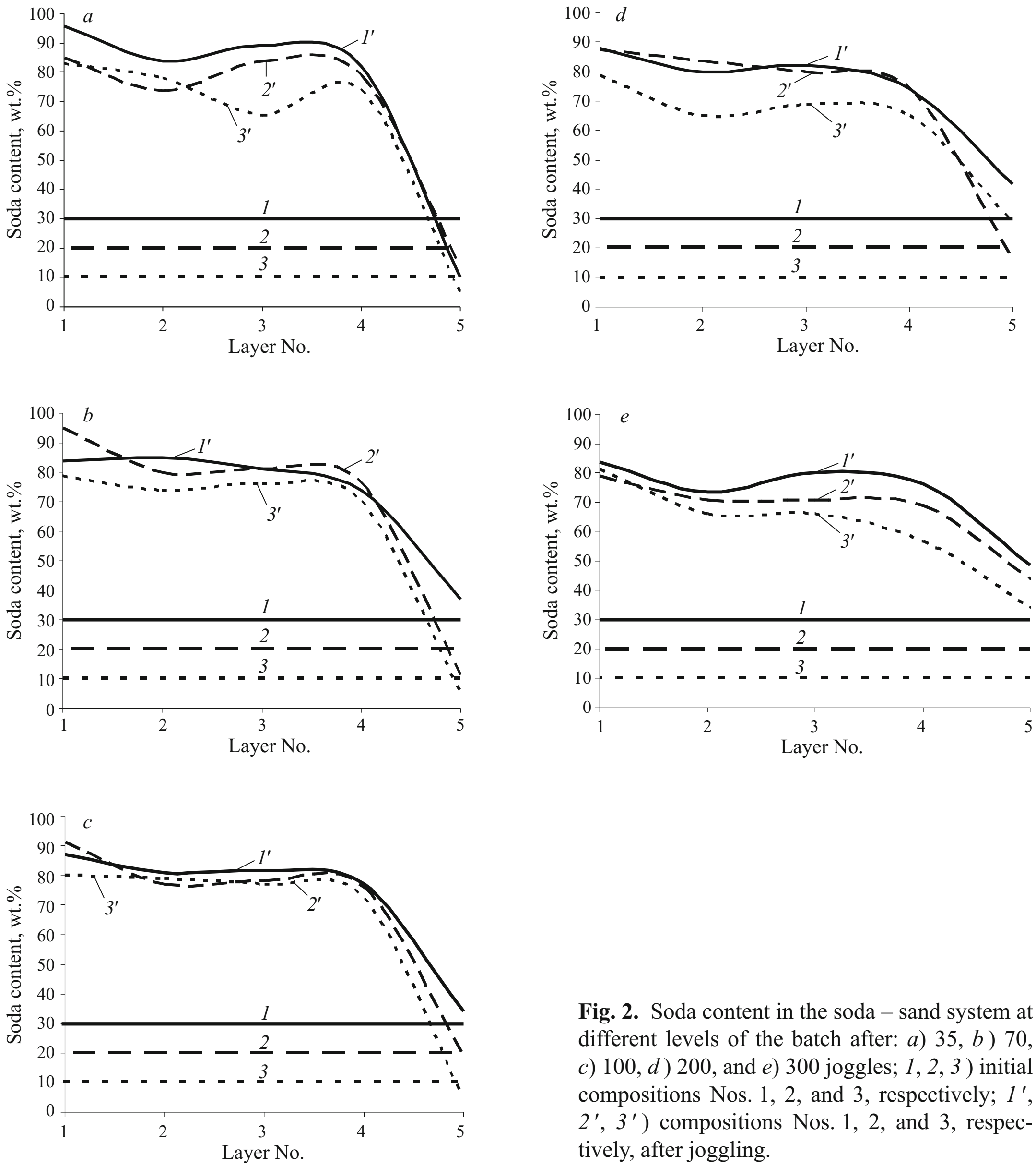

Fig. 2. Soda content in the soda – sand system at different levels of the batch after: *a*) 35, *b*) 70, *c*) 100, *d*) 200, and *e*) 300 joggles; *1*, *2*, *3*) initial compositions Nos. 1, 2, and 3, respectively; *1′*, *2′*, *3′*) compositions Nos. 1, 2, and 3, respectively, after joggling.

cylinder and the powder were joggled a definite number of times with amplitude approximately 15 cm (Fig. 1*b*). This modeled the mechanical action on glass batch in actual production. After the joggles the rod was inserted into the cylinder and, using the piston, the material was moved up to the cap (Fig. 1*c*), thereby compacting the material. The material in the cylinder was divided into equal portions (layers) along the vertical direction. To extract the bulk material the cap was removed and a special platform *6* was put in place. Portions of the material were scraped into a vessel (Fig. 1*d*) for investigation.

The following initial ratios of the components were used to study segregation in the soda – sand system (%[3]): 30/70, 20/80, and 10/90, respectively. The uniform mixture was joggled 35, 70, 100, 200, and 300 times. Then each composition was divided into five layers. The portions were weighed on an electronic balance. The soda content in each portion was calculated using a different bulk density of the initial components.

To study the separation of the dry-dolomite fractions the dolomite was first crushed and ground. This gave the following ratios of the dolomite fractions: 1 – 2 mm — 52.9%, 0.5 – 1 mm — 7.4%, < 0.5 mm — 39.7%. The initial batch with uniform separation of the fractions was joggled 35, 70, and 100 times. Each composition was divided into three layers. The portions were weighed on the balance. Next, the material of the portions was passed through a screen with 0.5 and 1 mm openings, and the content of each dolomite fraction in a portion was determined.

[3] Here and below, content by weight.

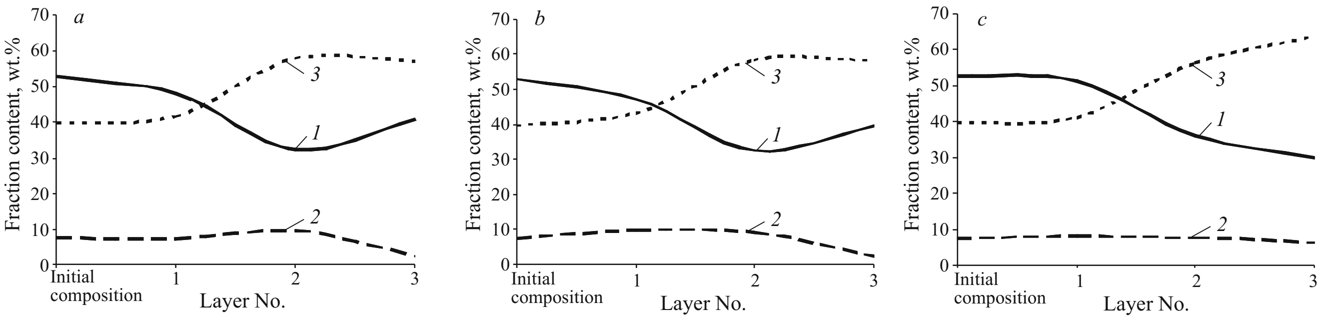

Fig. 3. Distribution of different dolomite fractions over the batch layers: *a*) 35, *b*) 70, *c*) 100 joggles; dolomite size fractions: *1*) 2 – 1 mm, *2*) 1 – 0.5 mm; *3*) < 0.5 mm.

Experimental Results. A plot of the soda content at different levels (layers) in the batch was constructed from the experimental results for the two-component soda – sand system (Fig. 2).

The curves obtained show a significant redistribution of the material over the height after mechanical action on the batch. In general, practically all soda, being the lighter material, goes into the upper layers of the batch irrespective of its

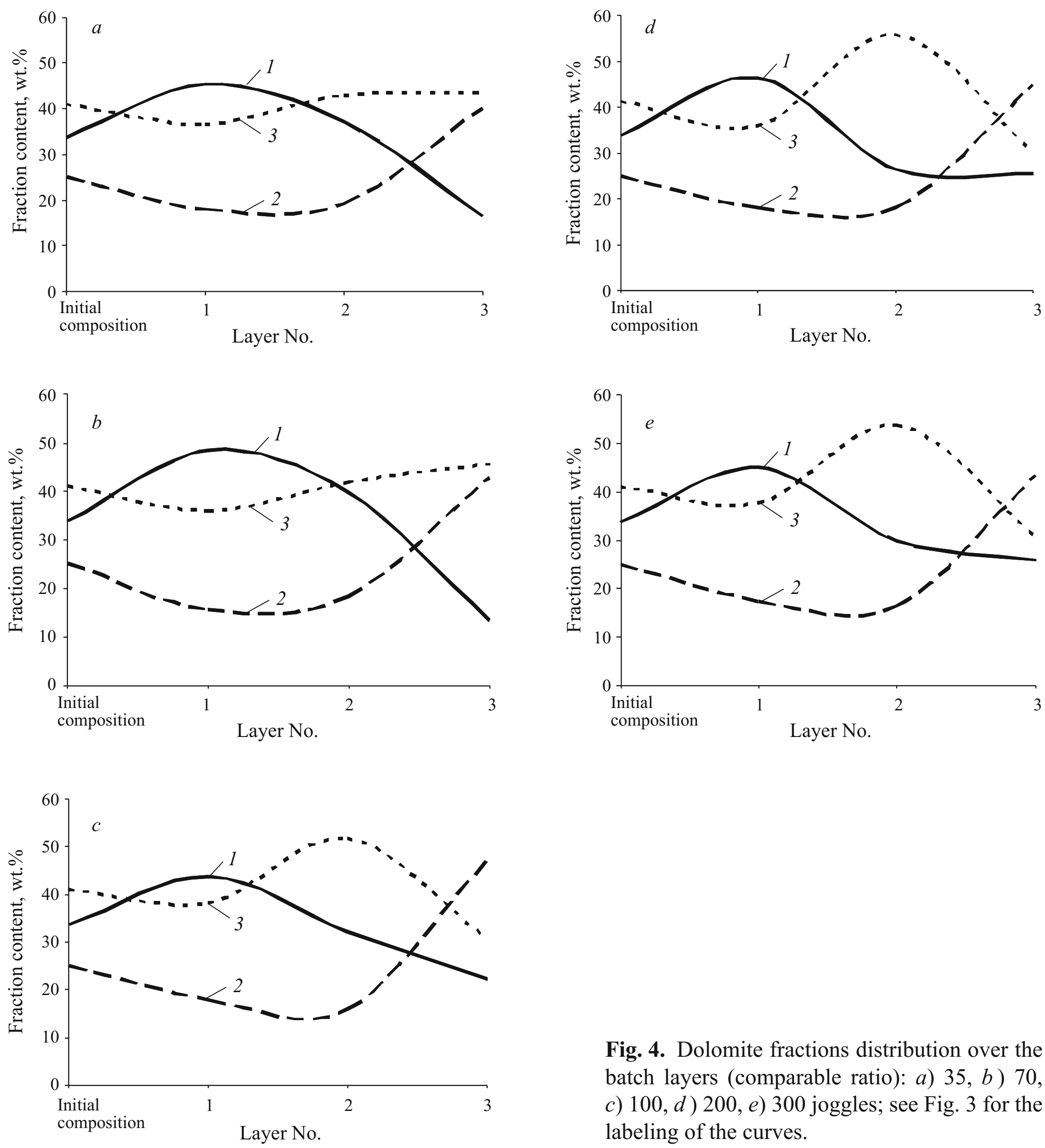

Fig. 4. Dolomite fractions distribution over the batch layers (comparable ratio): *a*) 35, *b*) 70, *c*) 100, *d*) 200, *e*) 300 joggles; see Fig. 3 for the labeling of the curves.

initial amount. This tendency is observed for any number of joggles. We note that the composition of the components from the first to the fourth layer remains practically unchanged and the amount of soda in the bottom layer decreases sharply. Especially large changes occur under small mechanical loads (35 – 100 joggles). The distribution of the components stabilizes when the number of joggles is large.

Plots of the distribution of different fractions of the material over the batch layers after mechanical action were constructed for dolomite powder (Fig. 3).

When the dolomite was comminuted the amount of the medium-size fraction was small. The distribution of this fraction over the levels remained practically unchanged. The coarse and fine fractions show regular behavior: from the top to the bottom layer the amount of the fine fraction increases while that of the coarse fraction decreases.

Subsequent experiments with dry dolomite were performed with a comparable ratio of different fractions: 1 – 2 mm — 38.9%; 0.5 – 1 mm — 22.2%; < 0.5 mm — 38.9%. The experimental results are presented in Fig. 4.

As follows from Fig. 4, the content of the coarse fraction decreases on crossing into the bottom layer. This dependence is different from the preceding one (see Fig. 3), and this tendency is seen in all experiments. The medium-size fraction exhibits the opposite behavior: its content increases on crossing into the bottom layers. The content of these two fractions changes in a relatively regular manner. The content of the fine fraction increases somewhat on crossing into the bottom layer only if the external actions are negligible (35 and 70 joggles). For substantial external actions its fraction increases on crossing into the middle level and decreases in the bottom layer. We also note that the largest change is observed on passing from 35 to 100 joggles, after which the nature of the changes remains the same.

CONCLUSIONS

The distribution of the components in the two component soda – sand mixture and the change of the ratios of the dolomite fractions under mechanical actions were studied experimentally. It was shown that soda, being the lighter material, migrates into the surface layers, while sand remains in the bottom layer. In addition, the difference of the concentrations reaches factors of 4 – 8. Serious segregation (150 – 200%) of the components was found for dolomite in both cases because of the different size of the particles.

REFERENCES

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